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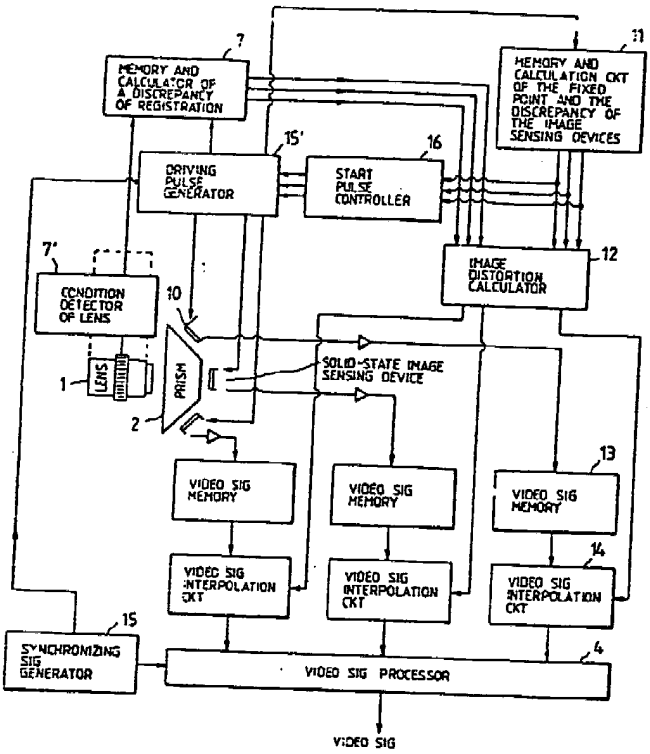
(54) Misregistration correction for a solid-state image pick-up apparatus.

(57) An image pickup apparatus comprises a two-dimensional filter for interpolating the registration discrepancy due to the chromatic aberrations of the lens used; and a two-dimensional filter for correcting the fixing discrepancy of an image pickup element, so that the registration discrepancy may be corrected by guiding video signals from the image pickup element through said two-dimensional filters.

EP 0 350 794 A2

FIG. 1


MEMORY AND CALCULATOR OF A DISCREPANCY OF REGISTRATION
7
MEMORY AND CALCULATION CKT OF THE FIXED POINT AND THE DISCREPANCY OF THE IMAGE SENSING DEVICES
11
DRIVING PULSE GENERATOR
15'
START PULSE CONTROLLER
16
IMAGE DISTORTION CALCULATOR
12
CONDITION DETECTOR OF LENS
7'
10
LENS
1
PRISM
2
SOLID-STATE IMAGE SENSING DEVICE
VIDEO SIG MEMORY
VIDEO SIG MEMORY
VIDEO SIG MEMORY
13
VIDEO SIG INTERPOLATION CKT
VIDEO SIG INTERPOLATION CKT
VIDEO SIG INTERPOLATION CKT
14
SYNCHRONIZING SIG GENERATOR
15
VIDEO SIG PROCESSOR
4
VIDEO SIG

SOLID STATE IMAGE PICKUP APPARATUS

BACKGROUND OF THE INVENTION

The present invention relates to a color solid state image pickup camera and, more particularly, to a solid state image pickup apparatus capable of correcting the discrepancy of registration (which will be shortly referred to the "registration discrepancy") due to the fixed point discrepancy of a solid state image pickup element or the chromatic aberration of a camera lens. At present, the broadcasting stations use widely the tripple-tube TV cameras. Being backed in recent years by the abrupt development of the solid state image pickup element, however, the image pickup tubes are being replaced by multi-disc TV cameras using the solid state image pickup elements.

Fig. 7 is a block diagram showing the tripple-tube camera schematically as one example of the prior art. An incident ray is separated by a lens 1 and a prism 2 into image signals of primaries (i.e., red R, green G and blue B colors), which are individually transformed into electric signals by camera tubes 3. After this, these electric (or image) signals are processed through a video signal processor 4 to generate video signals.

If the centers of the images of the colors separated by the prism of Fig. 7 are misaligned for the tubes from those of the light receiving faces of the image pickup tubes or if the lens has chromatic aberrations or the like, the positions of the images contained in the video signals are offset for the individual colors to form a twin image (due to the registration discrepancy) or to run the colors or to drop the resolutions thereby to deteriorate the image qualities. This problems likewise arises in the multi-disc camera. This makes it necessary for both the multi-tube and multi-disc types to register the images of the individual tubes or elements highly accurately.

In the case of the image pickup tube, the positioning of the photodetect areas can be corrected to some extent by adjusting the deflection signals of an electron beam. In the multi-tube camera of the prior art, those characteristics of the image pickup tube are utilized to register the photodetect areas of the three tubes by adjusting the current flow of a deflection signal generator 6 shown in Fig. 7.

Specifically, the conditions such as the positions and the aperture angles (which correspond to the zooming ratio, the F-number and the distance to an object) are detected at first by a lens condition detector 7′ which is composed of a potentiometer or a rotary encoder mounted in the lens. On the other hand, the aberration of the lens is changed with the position on a picture, the colors of the ray or the lens conditions such as the zooming ratio, the F-number or the distance to an object. Therefore, these data are stored in advance in a memory/calculator 7 of the registration discrepancy. On the basis of these stored data, the registration discrepancies at the individual picture positions are calculated from the lens conditions obtained from the lens condition detector 7′. On the basis of these registration discrepancies, the deflection signal generator 6 accomplishes the correction by adding a modification to the current of the deflection signals (as disclosed on pp. 40 to 47 of TV Association Vol. 1. 36, No. 10 (1982)).

Thus in the camera using the image pickup tube, the position of the photodetect area can be corrected to some extent by adjusting the deflection signal of the electron beam to leave an allowance for the fixed point of the image pickup tube. Moreover, the registration discrepancy of the chromatic aberration of the lens can also be adjusted to some extent.

In the solid state image pickup element, however, the image position is fixed on the photodetect plane so that the positional distorsion cannot be freely corrected unlike the image pickup tube. As a result, the multi-disc camera is required to have a high accuracy in the fixed point registration of each image pickup element and in the in the fixing method or the characteristics of the lens used.

On the other hand, the TV system at present is being examined to make the existing NTSC system finer. The picture element pitch of the solid state image pickup element used in this system is far smaller than that of the prior art to require a more severe accuracy in the fixed point of the element and in the lens. This severe accuracy makes the adjustment difficult and raises problems that the adjusting device costs dear to raise the production cost and that an expensive lens has to be used.

SUMMARY OF THE INVENTION

The present invention contemplates to provide a solid state image pickup apparatus which is enabled to form an image of excellent quality by registration discrepancy correcting means even if the fixing accuracy of the solid state image pickup element and the lens performance are not so high.

In order to the above-specified object, according to the present invention, the discrepancy of the image due to the fixed point discrepancy of the image pickup element is corrected in the following manner. Even if the fixing point of the solid state

image pickup element is misaligned from the optic axis of the optical lens, the photodetect area of the solid state image pickup element to be used is widened to produce image signals of necessary picture elements from the vicinity of the optic axis, and the number of picture elements is accordingly increased in advance. After the solid state image pickup element is fixed in the optical system, moreover, the positional relations between the photodetect area of the solid state image pickup element and the optical lens with the optic axis are measured in advance, and their data are stored in the camera. Moreover, a two-dimensional filter is provided for anticipating the image level of each picture element in the effective picture element area necessary for the image output so that the video signal obtained from each picture element of the solid image pickup element may be guided through the two-dimensional filter to output interpolated signals. Here, the coefficient of the two-dimensional filter to be used is determined and used for each picture element or for a predetermined block on the basis of the fixed point discrepancy stored.

On the other hand, the registration discrepancy due to the chromatic aberration of the lens is corrected in the following manner. In addition to the aforementioned two-dimensional filter for correcting the fixed point discrepancy of the image pickup element, there is provided a two-dimensional filter for interpolating the registration discrepancy due to the chromatic aberration. The video signal obtained from each picture element of the solid state image pickup element is guided through those two two-dimensional filters so that it may be outputted with its registration discrepancy being interpolated. Alternatively, the coefficient of the two-dimensional filter for correcting the fixed point discrepancy of the image pickup element is interpolated at one time and outputted through one two-dimensional filter which has been corrected considering the registration discrepancy due to the chromatic aberration.

Here, the coefficient of the aforementioned additional two-dimensional filter is determined for each picture element or the predetermined block on the basis of the discrepancy of each picture element, which is determined the position and color on the picture and the conditions (e.g., the zooming ratio, the F-number and the distance to the object) of the lens. Moreover, the correction of the coefficient of the two-dimensional filter for the one-time interpolation is carried out by using the coefficient determined from the aforementioned lens conditions.

According to the present invention, the image signals of the necessary area can always be obtained from the solid state image pickup element even with the discrepancy in the fixed point of the solid state image pickup element.

Even if, moreover, the output signals of the solid state image pickup element have the registration discrepancy due to the fixed point discrepancy of the image pickup element or the chromatic aberration of the lens, the image signals having no registration discrepancy and necessary for the image output are determined by interpolating the output signals of the solid state image pickup element so that a high accuracy need not be required for the fixing accuracy of the image pickup element or the characteristics of the lens used.

BRIEF DESCRIPTION OF THE DRAWINGS

Figs. 1 to 6 are diagrams showing and explaining a first embodiment of the present invention;

Fig. 7 is a block diagram showing the circuit of the prior art;

Fig. 8 is a diagram showing a second embodiment of the present invention;

Figs. 9 to 11 are diagrams showing and explaining a third embodiment of the present invention;

Fig. 12 is a diagram showing a fourth embodiment of the present invention; and

Figs. 13 to 15 are diagrams showing a fifth embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The first embodiment of the present invention is shown in Fig. 1. In the circuit of the prior art, as shown in Fig. 7, the deflection signal is finely adjusted to move the position of the photodetect area directly on the image pickup tube. On the contrary, the circuit of Fig. 1 is different from the circuit of the prior art in that the data such the fixed point discrepancy of the image pickup element or the chromatic aberration of the lens are stored in advance, in that the registration discrepancy is calculated on the basis of those stored data, and in that the image signal obtained from each picture element of the solid state image pickup element is guided through the two-dimensional filter determined by that registration discrepancy so that the image singals necessary for the picture output may be anticipated and interpolated.

In Fig. 1, the images separated by a prism 2 are transformed into electric signals by respective solid state image pickup elements 10. The number of the picture elements of the solid state image pickup element used at this time is usually more by about two to five in the vertical and horizontal

directions, as necessary for eliminating the influences of the peripheral portions of the effective picture elements. In the present invention, however, even if the fixed position of the solid state image pickup element is misaligned from the optic axis 20 of the optical lens, as shown in Fig. 2, the photodetect areas 22 and 24 of the solid state image pickup element used are widened to produce all the image singals of effective picture elements 21 necessary for the output from the vicinity of the optic axis, and the total number of the photodetect picture elements is accordingly increased (although only the relations between the two discs for simplicity of descriptions). Specifically, the photodetect area of the solid state image pickup element is widened to have more than the following picture element numbers:

Vertical: Picture elements of (Nv + Mv); and

Horizontal: Picture elements of (Nh + Mh),

if the numbers of the effective picture elements necessary for the output are designated at Nv in the vertical direction (i.e., the length Lv on the elements in the image pickup tube) and at Nh in the horizontal direction (i.e., the length Lh on the elements in the image pickup tube), and if the picture element number converted values of the fixing discrepancy for all the picture elements having an equal pitch are designated at Mv in the vertical direction (i.e., the length Jv on the elements in the image pickup tube) and at Mh in the horizontal direction (i.e., the length Jh on the elements in the image pickup tube).

A memory/calculator 11 of the fixed point and the discrepancy of the image pickup elements is a circuit for storing and calculating the data relating to the fixed point and the discrepancy of the image pickup elements. Specifically, the memory/calculator 11 measures in advance and stores the data, which are necessary for calculating the discrepancy of each picture element due to the fixing discrepancy after the solid state image pickup elements have been fixed in the optical system, such as the positions 23 and 25 and the angle of rotation 26 in the photodetect area, in which the photodetect area of the solid state image pickup elements and the optic axis of the optical lens intersect. On the basis of these data, the memory/calculator 11 calculates the discrepancy of each picture element and outputs it to an image distorsion calculator 12. Incidentally, the discrepancies may be calculated and stored in advance in the table so that they may be sequentially read out and outputted.

On the other hand, a memory/calculator 7 of registration discrepancy is a circuit for storing and calculating the data such as the chromatic aberration of the lens. An example of the more detailed structure of this circuit is shown in Fig. 3. An aberration data table 7-2 is a circuit for storing the characteristics of the lens such as the coefficients of the functions of approximating curves (e.g., the coefficients of three-dimensional functions) expressing the picture dependencies of image discrepancies (e.g., the discrepancy of the R and B signals from the G singal), for example. Since, however, these discrepancies are varies according to the colors of the incident ray or the lens conditions (e.g., the zooming ratio Z, the F-number F or the distance L to the object), it is necessary to prepare the data table corresponding to the respective conditions. Moreover, the coefficients of the approximating functions are desired to change as smoothly as possible by the linear approximations so that the image may not be unnaturally changed when the conditions are changed. After these preparations, the following calculations are accomplished. Specifically, a scanning point detector 7-1 calculates the picture positions of the output signals on the basis of the synchronizing signals (e.g., a horizontal synchronizing signal HD, a vertical synchronizing signal VD and a clock CLK) obtained from a synchronizing signal generator 15 and a driving pulse generator 15'. In an interpolator 7-3, moreover, the discrepancy of each picture element is calculated and outputted to the image distorsion calculator 12 from the picture position determined by the scanning point detector 7-1, the conditions (i.e., the zooming ratio, the F-number and the distance to the object) obtained from a lens condition detector 7'', and the lens conditions stored. Incidentally, these discrepancies may be calculated and stored in advance in the table so that they may be sequentially read out and outputted.

The image distorsion calculator 12 of Fig. 1 is a circuit for totaling the registration discrepancies caused by the lens conditions and the fixing discrepancies, to determine the final image distorsion. Incidentally, the input signals from the memory/calculator 11 of the fixed point and the discrepancy and the memory/calculator 7 of registration discrepancy may be exemplified by not those registration discrepancies for those causes but only the data necessary for calculating the individual discrepancies such as the angle of rotation of the elements or the coefficients of the approximating functions, so that the final image distorsion may be calculated at one time in that image distorsion calculator.

Next, one example of the interpolation method for calculating the levels of the image signals necessary for the output from the output signals of the solid state image pickup elements 10 will be described in the following. Fig. 4A is a diagram showing the relations schematically between the picture elements (or sampling points) of the solid state image pickup elements at this time and the image

positions. In Fig. 4A, circles indicate the positions of the picture elements. Moreover, letters n, n+1, n+2, ..., and so on designate the line numbers of the individual scanning lines whereas the letters m, m+1, m+2, ..., and so on designate the picture element numbers in the horizontal direction. For simplicity, there is shown the case in which a white line in the horizontal direction is photographed. In Fig. 4A, a solid line indicates the line of the R image obtained at this time, and a single-dotted line indicates the line of the G image. The image of the same point to be formed in the picture element point (n+2, m+3) in the G image is focused with a discrepancy at a point X in the R image. As a result, the image of the R image at the same point as that of the signal of the G image obtained from the picture element point (n+2, m+3) cannot be directly obtained from the solid state image pickup elements. Therefore, the R signal level R' of the point X is determined from the following two-dimensional filter equation:

$$R' = \sum_{i,j=1}^{2} a_{i,j} \times R_{i,j}.$$

Here, letters $R_{i,j}$ designate the output level of the R signal obtained from the four points (as indicated in an enlarged scale in Fig. 4B) adjacent to the point X, as indicated by a square frame. On the other hand, the value of the coefficient $a_{i,j}$ is deduced from the following equations using the letters appearing in Fig. 4B:

$a_{1,1} = q \times s$, $a_{1,2} = q \times r$; and

$a_{2,1} = p \times s$, $a_{2,2} = p \times r$,

wherein: $p + q = 1$; and $r + s = 1$.

As is apparent from Fig. 4B, the coefficient values have to be changed for the magnitude of the registration discrepancy of the R image.

In the circuit of Fig. 1, these interpolations are accomplished in the following manner. Of the electric signals transformed by the solid state image pickup elements 10, at least the signals of a portion of a picture in the vicinity of the discrepancy of the image are sequentially stored in video signal memories 13 in accordance with the picture element position of the output (although the signals read out from the image pickup elements are amplified to a predetermined level). On the other hand, the coefficients of the two-dimensional filter are determined according to the above-specified equations by the coefficient calculating portions of video signal interpolators 14. At the same time, the interpolation signal levels are calculated by the interpolation portions of the video signal interpolators 14 from the picture element signals stored in the video signal memories 13 and the coefficients deduced. The interpolation signals determined by the video signal interpolators 14 are fed like the prior art through a video signal processor 4 to produce video signals.

In the description made above, the interpolations are accomplished by linearly approximating two adjoining points. It is needless to say that the interpolations can be accomplished by approximating the two points by an arbitrary curve, more finely by approximating the signals of the picture element points over a wider range of 3 x 3, 5 x 5 or the like, or by substituting the signals of the most adjoining picture elements. Here in Fig. 5, there is shown an example for accomplishing those interpolations. Fig. 5A shows an example of a circuit for accomplishing the interpolations of the range of 3 x 3. Reference numerals 14-1 or "1HDL" designate a shift register for delaying the horizontal scanning interval or a circuit for timing the vertical direction. Numerals 14-2 or "LC" designates a latch circuit for operating with the horizontal driving clock of the solid state image pickup elements or a circuit for timing the horizontal direction. Numerals 14-3 designates a multiplier or a circuit for multiplying the adjacent signals $R_{i,j}$ by the coefficient $a_{i,j}$ of the two-dimensional filter. Numerals 14-4 designate an adder or a circuit for summing the results of the above-specified multiplications. On the other hand, Fig. 5B shows an example of the circuit for substituting the signals of the most adjacent picture elements. The multiplier 14-3 and the adder 14-4 of the circuit of Fig. 5A are replaced by a signal selector 14-5 for selecting the signal of the picture element closest to the focal point. Both of those circuit structures are given the function of the video signal memories 13.

In case, on the other hand, the lens conditions or the fixing accuracy of the image pickup elements are so poor that the registration discrepancy exceeds the pitch of several scanning lines or several picture elements, a center picture element address is desirably designated and restricted to the adjacent picture elements, as shown in Fig. 6, to eliminate the useless calculations.

Here, a start pulse controller 16 is inserted to suppress the storage capacity of the video signal memories 13 in connection with the parallel distorsion components of the fixing discrepancy of the image pickup elements. In the controller 16, the picture element signal read start pulse timing is calculated for each image pickup element to control the driving pulse generator 15' so that the picture element signals in the vicinity of the optic axis may be outputted at a substantially equal interval. As a result, the picture element signals necessary for the interpolations are outputted from the image pickup elements, while being timed with

the outputs of the interpolated picture element signals, to eliminate the necessary buffer memory for timing the output signals from the individual elements.

Incidentally, in the circuit of Fig. 1, in order to suppress the rounded discrepancy for calculating the image signals to anticipate and interpolate the signal levels of the picture element positions of the output, the distorsion of the image is determined including the distorsion due to the chromatic aberrations of the optical lens determined by the memory/calculator 7, so that the video signals may be calculated all at once. However, the corrections may be independently accomplished.

Although the descriptions have been made assuming the digital processing, it goes without saying that similar effects can be realized by the analog processing.

Thus in the present circuit, the distorsion of the images on the solid state image pickup elements can be corrected by the video signal processors. As a result, the solid state image pickup elements need not require excessively high accuracies in the fixed points of the image pickup elements or the characteristics of the lens used, although the positions of the photodetect areas cannot be freely moved on the image pickup places unlike the image pickup tubes.

Fig. 8 shows the second embodiment of the present invention. Generally speaking, the resolution of the optical lens is high at the center and the lower toward the periphery. In the picture periphery, therefore, it is desirable to enhance the high-frequency components of the video signals to the higher level in the picture periphery than at the center. Fig. 8 shows a circuit, which is composed of an enhancement coefficient calculator 41 and a matrix calculator 42 in addition to the circuit components of Fig. 1, so that a variety of two-dimensional filtering operations (e.g., noise suppressing filtering operations) including the aforementioned enhancement can be accomplished.

The discrepancy of the image due to the lens aberrations and the fixing discrepancy of the elements is determined like the circuit of Fig. 1 by the memory/calculator 7, the memory/calculator 11 and the image distorsion calculator 12. In the enhancement coefficient calculator 41, on the other hand, the enhancement or other coefficients for each picture element is determined, and the coefficient of the matrix of 3 x 3 (which may be generally 2 x 2 or more), for example, like that of the ordinary two-dimensional filter (as disclosed on pp. 113 of "Digital Signal Processing of Images" published by Nikkan Kogyo Shinbun), is accordingly determined. In the matrix element calculator 42, moreover, the matrix coefficients are corrected with the image distorsion determined by the image distorsion calculator 12. After this, the video signal interpolators 14 interpolate the picture element signals by using the coefficients of the matrix determined by themselves, while considering all the image distorsions and the enhancement. The interpolated output signals of the video signal interpolators 14 are fed like the prior art to the signal processor 4 to produce the video signals.

The matrix elements to be ordinarily used for the interpolations are fractions composed of simple integers so that the they can be calculated relatively easily. On the contrary, the calculations such as the picture element interpolations or the enhancements folloiwng the image distorsions handle the video signals requiring the high accuracy. If similar calculations are repeated, the rounding errors are accumulated to raise a defect that the image quality is deteriorated.

In the present circuit, not only the image distorsions but also the coefficients necessary for the various two-dimensional filtering of the enhancers are rounded in advance, and the calculations of the video signals requiring the high accuracy are accomplished all at once. Thus, the rounding error in the video signal calculations can be reduced to a low level.

In the present circuit, as in the circuit of Fig. 1, the image distorsions can be corrected so that the high accuracy need not be required for the fixing accuracy of the image pickup elements and the characteristics of the used lens.

Fig. 9 shows the third embodiment of the present invention. The solid state image pickup element generally has a structure in which the picture elements are arrayed in a two-dimensional form, as shown in Fig. 10A. As shown in Figs. 10B and 10C, the scanning operations are sequentially accomplished with the driving pulses having a constant horizontal clock frequency and horizontal synchronizing frequency. The useless picture element signals unnecessary for the output shown in Fig. 2 can be eliminated for the periods corresponding to the horizontal blanking time and the vertical blanking time. If, however, the fixing accuracy is low, the number of the useless picture elements is increased so that the useless picture element signals cannot be eliminated for the horizontal blanking time and the vertical blanking time.

In order that the circuit of Fig. 9 may eliminate the useless picture element signals, the solid state image pickup elements are driven with the horizontal clock frequency and the horizontal synchronizing frequency, which are different from the horizontal clock frequency and the horizontal synchronizing frequency determined from the effective picture element number necessary for the TV system used for the output. However, the field frequency is equalized to that of the TV system used for the

output.

On the basis of the vertical synchronizing pulses (for determining the field frequency) outputted from the synchronizing signal generator 15, the driving pulses having a horizontal clock frequency and a horizontal synchronizing frequency higher than those determined by the TV system are generated by a driving pulse generator 53. These driving pulses are used to drive the circuits such as the solid state image pickup elements and the image distorsion calculator 12 up to the video signal interpolators 14. After this, the output signals of the video signal interpolators 14 are transformed by the signal processor into the video signals after they have passed through a time difference controller 54 for equalizations to the frequency of the output signals.

Thus, the present circuit can eliminate the useless picture element signals prepared and correct the position distorsion of the image, even in case the fixing accuracy of the solid state image pickup elements is poor so that the useless picture element signals cannot be eliminated by the drive of the ordinary clock frequency.

Incidentally, the description thus made with reference to Fig. 9 is directed to the case in which the signals are sequentially read out from the solid state image pickup elements for each horizontal line. However, the solid state image pickup elements can be simultaneously read out for several lines so that they may be driven with the driving pulses having a horizontal clock frequency and a horizontal synchronizing frequency lower than those determined by the TV system.

In order to eliminate the useless picture element signals, moreover, unlike the operations of Fig. 10 in which the drive is always accomplished with the constant clock frequency, the useless picture element signals, which could not be eliminated for only the period corresponding to the horizontal blanking time and the vertical blanking time of Figs. 11A and 11B, may be partially read out and eliminated at a high speed.

Fig. 12 shows the fourth embodiment of the present invention, in which the registration discrepancy in the horizontal direction is corrected by controlling the output timing of the signals coming from the image pickup elements.

Specifically, in case the image position of the R signal, for example, is distorted to the left from the image position of the G signal, the R signal is read out with such a slight delay that it may be read out simultaneously with that of the G signal. If the distorsion takes place in the reverse direction, i.e., to the right, the R signal is read out so slightly earlier that it can be outputted simultaneously with the G signal. Thus, the R, G and B signals of the same image position can be read out at common timing to correct the registration discrepancy in the horizontal direction.

Fig. 12 shows an example of the circuit for realizing the above-specified operations, in which only a portion relating to one image pickup element is taken out for simplicity. Like the circuit of Fig. 1, the registration discrepancy calculated by the image distorsion calculator 12 is inputted to a clock controller 61. Moreover, the frequency of the clock signal is controlled directly in conformity to the registration discrepancy to adjust the timing, at which the signals are to be read out from the image pickup element, so as to accomplish the interpolations. On the other hand, a delay time controller 62 is a circuit for controlling a variable delay line 63 added. The delay time controller 62 controls the delay of the variable delay line 63 in conformity with the registration discrepancy, which is calculated by the image distorsion calculator 12, to adjust the output timing of the signals indirectly for the interpolations. Incidentally, the start phase of the driving pulses of the solid state image pickup element is adjusted through a start pulse controller 16′ in accordance with the changes in the frequency of the clock signal.

Thus, in the present embodiment, the registration discrepancy in the horizontal direction can be easily interpolated without interpolations of the output signals.

Although the description made above is directed to the case in which the two indirect methods are used together, it is apparent that only one of them may be used for the corrections.

The fifth embodiment of the present invention is shown in Fig. 13. The present embodiment is different from the first embodiment in that not only the lens condition detector 7′ of Fig. 1 but also the memory/calculator 7 of registration discrepancy is built in the lens itself.

Here, in the photography of the ordinary TV program, the taking lenses have to be exchanged so as to change the field angle. For example, a telephotolens having a long focal length is used for the outdoor photography whereas a wide angle lens having a short focal length is used for studio photography. In the camera using the image pickup tube of the prior art shown in Fig. 7, however, such troublesome operations have to be accomplished for each lens exchange as to rewrite the content of the aberration correction data stored in the camera body or to exchange the chip of read only memory (i.e., ROM) incorporated.

In the camera having the circuit structure of Fig. 13, on the contrary, the registration discrepancy memory/calculator 7 is replaced simultaneously with the lens exchange. As a result, the aberration correcting data stored in the memory/calculator 7 are also automatically ex-

changed to eliminate the above-specified troublesome operations.

In the present embodiment, moreover, it is important to store the aberration correcting data in each lens, but there is no necessity for storing all the contents of the memory/calculator 7 in the lens. For example, as shown in Fig. 14 (in which only the optical system and the portion of the memory/calculator 7 are shown for simplicity), the lens may store only the aberration data table 7-2 or the circuit of the memory/calculator 7 for storing the lens characteristics. Alternatively, as shown in Fig. 15, the lens is additionally equipped with an aberration data memory 1-2 which is composed of the ROM or the like to store the lens characteristics. When the lens is exchanged, the lens characteristics stored are read in the aberration data table 7-2 of the memory/calculator 7 in the camera body so that the ordinary corrections may be subsequently accomplished by using the data of the aberration data table 7-2 stored in the lens body. It is quite natural that the image position data of the scanning point detector 7-1 may be sent to the aberration data memory 1-2 to calculate the registration discrepancy directly by using the data in the aberration data memory 1-2.

Thus in the circuit of the present embodiment, the aberration correcting data are automatically exchanged simultaneously with the lens exchange to eliminate the troublesome operations of the prior art, which have to be accomplished for each lens exchange.

The description made above is directed to the case in which all the R, G and B signals are interpolated. By taking the image position of one signal (e.g., the G signal) as a reference, the registration of the signal of other element is interpolated to adjust the relative position to the position of the reference image. Moreover, this reference signal (e.g., the G signal) may be omitted so long as its image is not highly distorted.

Moreover, only either of the horizontal or vertical direction may be interpolated although the effects re weakened.

Although only the chromatic aberrations of the lens are taken up as the characteristics of the optical system, it is needless to say that the registration discrepancy due to the prism 2 for separating the incident ray into the primaries may be likewise interpolated.

Although the description thus far made is stressed on the tripple-disc type, the present invention can also be likewise applied to not only the single-disc type or duel-disc type for separations of primaries but also a monochromatic camera.

Moreover, the image pickup apparatus using the image pickup tube may apparently use not the deflection with the electron beam but the method of the present invention, i.e., the method of correcting the image distorsion by calculating the signals read out. Especially in the image pickup tube camera for the digital signal processing, it is easy to realize the registration correction by the two-dimensional digital filter. Although the fifth embodiment has been described in the case of using the solid state image pickup elements, the present invention can apparently be applied as it is to the camera using the image pickup tube.

On the other hand, the description thus far made is directed to the case in which the data relating to the registration discrepancy are measured and stored so that the discrepancy may be calculated from the stored data. It is apparent to add a registration discrepancy detector for detecting the discrepancy directly from the video signals outputted from the image pickup elements, so that the interpolations may be accomplished by using the registration discrepancy detected.

As has been described hereinbefore, according to the present invention, the video signals of the necessary area can be obtained at all times from the solid state image pickup elements even if the fixing positions of the solid state image pickup elements are distorted. Even if, moreover, the output signals are caused to contain the registration discrepancy by the fixing discrepancy of the image pickup elements or the chromatic aberrations of the lens, the video signals necessary for the output and having no position distorsion are determined by interpolations from the output signals of the solid state image pickup elements. A high accuracy is not required of the fixed point of the image pickup elements and the characteristics of the lens used.

Claims

1. An image pickup apparatus including an optical lens (1) and an image pickup element (10) for transforming the optical ray having passed through said optical lens (1) into electric signals, comprising:

means (7) for storing at least either of the fixing distortion of said image pickup element (10) and a chromatic aberration;

means (7) for calculating a registration discrepancy on the basis of the data stored; and

means (14) for anticipating and interpolating video signals necessary for the output by guiding the video signals obtained from the individual picture elements of said image pickup element (10) through a two-dimensional filter determined by the registration discrepancy calculated.

2. An image pickup apparatus including an optical lens (1) and an image pickup element (10) for transforming the optical ray having passed

through said optical lens 1 into electric signals,
wherein said image pickup element (10) has a photodetect area larger than the following size:
(Lv + Jv) x (Lh + Jh),
wherein:
Jv = the vertical fixing distortion when said image pickup element (10) is fixed at the back of said optical lens (1),
Jh = the horizontal fixing distortion,
Lv = the vertical length of the effective photodetect area necessary for the output,
Lh = the horizontal length.

3. An image pickup apparatus including: an optical lens (1); and a solid state image pickup element (10) composed of a plurality of photoelectric transforming elements for transforming the optical ray having passed through said optical lens (1) into electric signals and having a structure of picture elements arrayed two-dimensionally,
wherein the numbers of the picture elements contained in the photodetect area of said solid state image pickup element (10) are:
Mv + Nv or more in the vertical direction; and
Mh + Nh or more in the horizontal direction,
wherein the picture element number converted value of the fixing discrepancy, when said solid state image pickup element is to be fixed at the back of said optical lens, is designated Mv in the vertical direction and Mh in the horizontal direction.

4. The apparatus of Claim 1, wherein the field frequency for reading out signals from said image pickup element (10) is equal to that of the TV system used for the output, and wherein the scanning rate in the horizontal direction is different from the horizontal scanning rate which is determined from the effective photodetect area necessary for the TV system used for the output.

5. The apparatus of Claim 2, wherein at least a portion of the signals stored in the area except the effective photodetect area for obtaining the signals to be used for the output within the photodetect area of said image pickup element (10) is read out at a rate higher than that for reading out the signals in said effective photodetect area.

6. An image pickup apparatus comprising:
at least one of a memory for storing the fixing discrepancy data of an image pickup element, on which the optic axis of an optical lens is fixed, a memory for storing the lens characteristics such as the aberrations of said optical lens, and a memory for storing other characteristics such as the temperature characteristics of an optical prism;
a calculator for calculating the discrepancies of the positions of each point in the effective photodetect area represented by a point being noted and a point on said fixed image pickup element from at least one of the data in said memory, the positional data in the picture of the point being noted, and the condition data indicating the operating conditions of said optical lens;
a video signal memory for storing at least a portion of the signals obtained from said image pickup element; and
an interpolator for anticipating and interporating the video level of each point in said effective photodetect area necessary for said output by reading out a portion of the video signals according to said calculated discrepancies from the video signals stored in said video signal memory and by calculating the video signals read out in a predetermined manner.

7. The apparatus of Claim 6, wherein an enhancement for stressing the high-frequency component of the image is accomplished simultaneously with the anticipation and interpolation of the video level from the discrepancies between the each point in the effective photodetect region necessary for said output and each point in the photodetect area of said fixed image pickup element.

8. The apparatus of Claim 6, wherein the timing for starting the vertical or horizontal reading-out of the signal from said image pickup element is shifted to an early or late side from that in case the optic axis of said optical lens extends through the center of the photodetect area of said image pickup area, so that the positional correction for the fixing discrepancy of said image pickup element may be smaller than that in the case of the start timing assuming that the optic axis of said optical lens extends through the center of the photodetect area of said image pickup element.

9. The apparatus of Claim 6, wherein two or more image pickup elements are used, further comprising:
a calculator for calculating the discrepancy of the image on the other of said image pickup elements with respect to the image on one image pickup element providing the fixing reference; and
a video interpolator for anticipating and interpolating the video level of each point in the effective photodetect area necessary for said output from said calculated discrepancy.

10. The apparatus of Claim 1, further comprising:
an oscillator for controlling an oscillatory frequency; and
a driver for controlling the drive starting timing of said image pickup apparatus,
whereby at least one of the oscillatory frequency of said oscillator and said drive starting timing in accordance with the discrepancy of the image of the signals obtained from said image pickup element.

11. An image pickup apparatus according to Claim 1, further comprising:

a video signal delay circuit for controlling a delay time to a predetermined value,
whereby the delay time of said video signal delay circuit is controlled to the predetermined value in accordance with the discrepancy of the image of the signals obtained from said image pickup element.

12. A photographic lens for an image pickup apparatus, comprising:
a lens body; and
a memory for storing data indicating the chromatic aberrations according to the conditions of said lens.

FIG. 1

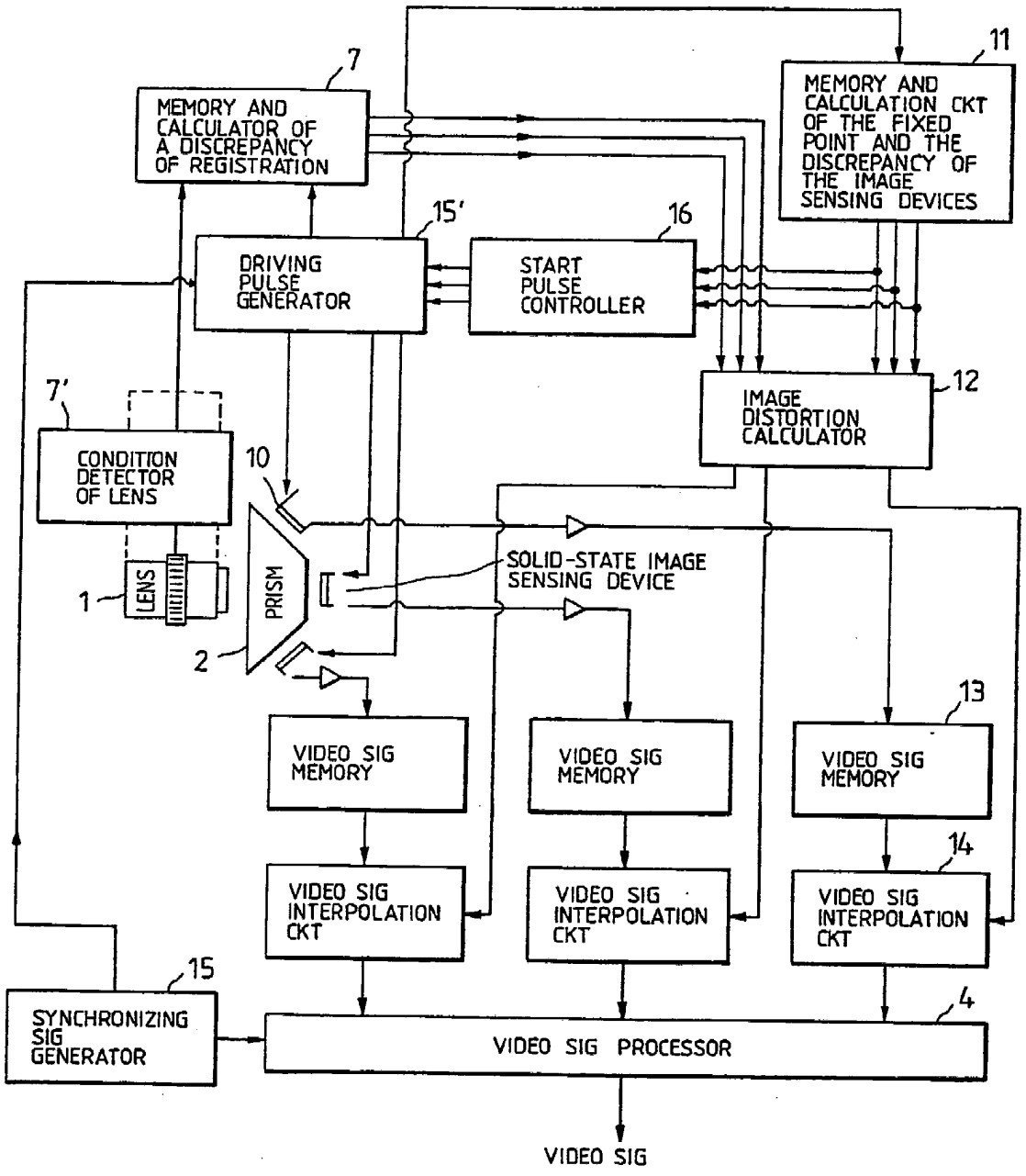

7
MEMORY AND CALCULATOR OF A DISCREPANCY OF REGISTRATION
11
MEMORY AND CALCULATION CKT OF THE FIXED POINT AND THE DISCREPANCY OF THE IMAGE SENSING DEVICES
15'
DRIVING PULSE GENERATOR
16
START PULSE CONTROLLER
12
IMAGE DISTORTION CALCULATOR
7'
CONDITION DETECTOR OF LENS
10
1
LENS
PRISM
2
SOLID-STATE IMAGE SENSING DEVICE
13
VIDEO SIG MEMORY
VIDEO SIG MEMORY
VIDEO SIG MEMORY
14
VIDEO SIG INTERPOLATION CKT
VIDEO SIG INTERPOLATION CKT
VIDEO SIG INTERPOLATION CKT
15
SYNCHRONIZING SIG GENERATOR
4
VIDEO SIG PROCESSOR
VIDEO SIG

FIG. 2

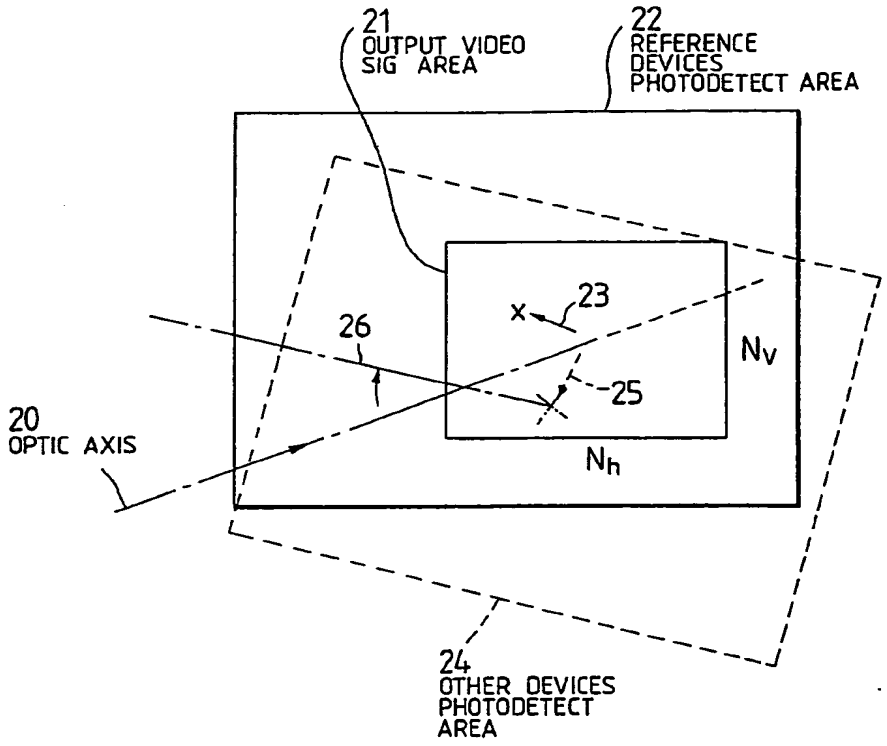

21
OUTPUT VIDEO
SIG AREA
22
REFERENCE
DEVICES
PHOTODETECT AREA
23
x
26
25
Nv
Nh
20
OPTIC AXIS
24
OTHER DEVICES
PHOTODETECT
AREA

FIG. 3

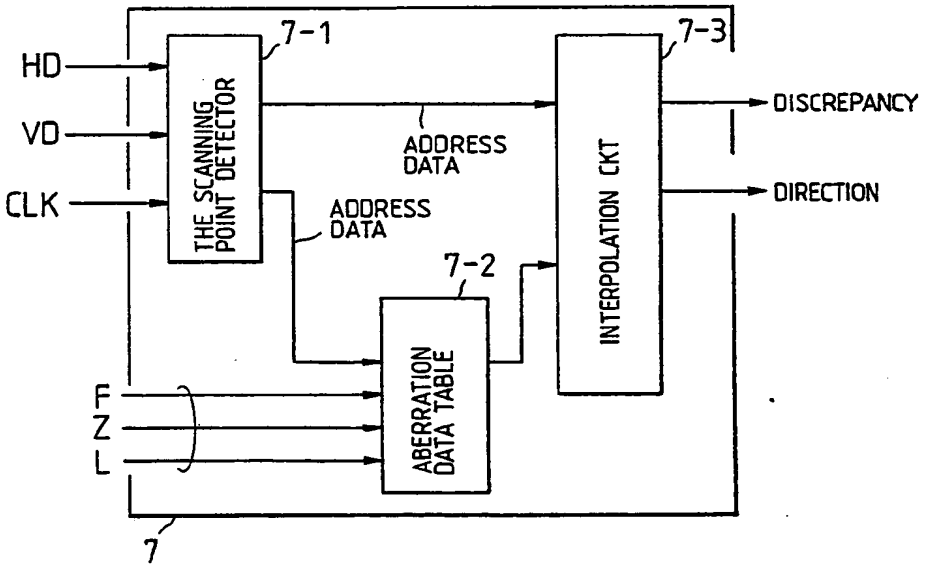

HD
VD
CLK
THE SCANNING POINT DETECTOR
7-1
ADDRESS DATA
ADDRESS DATA
7-2
ABERRATION DATA TABLE
F
Z
L
INTERPOLATION CKT
7-3
DISCREPANCY
DIRECTION
7

FIG. 4A

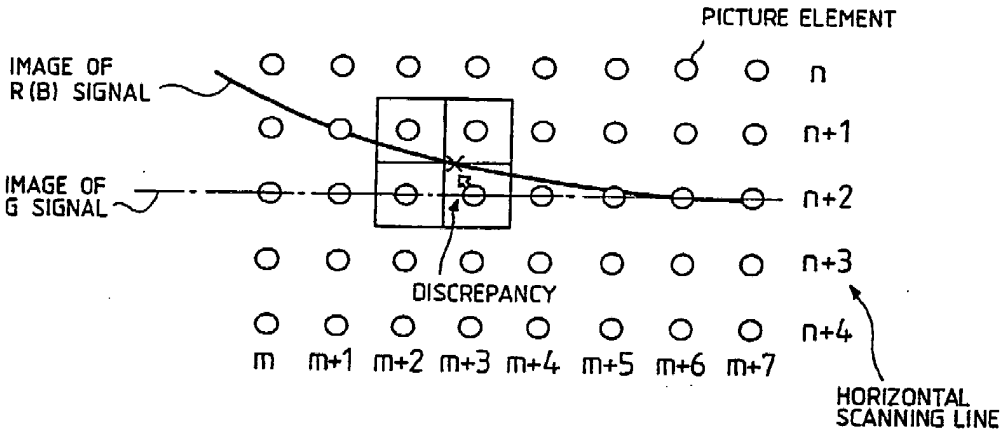

PICTURE ELEMENT
IMAGE OF
R(B) SIGNAL
IMAGE OF
G SIGNAL
DISCREPANCY
n
n+1
n+2
n+3
n+4
m
m+1
m+2
m+3
m+4
m+5
m+6
m+7
HORIZONTAL
SCANNING LINE

FIG. 4B

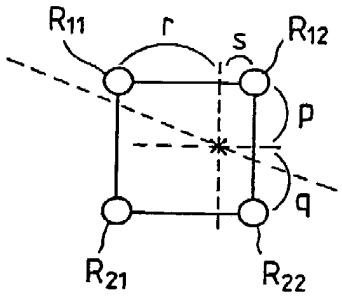

R11
r
s
R12
p
q
R21
R22

FIG. 5A

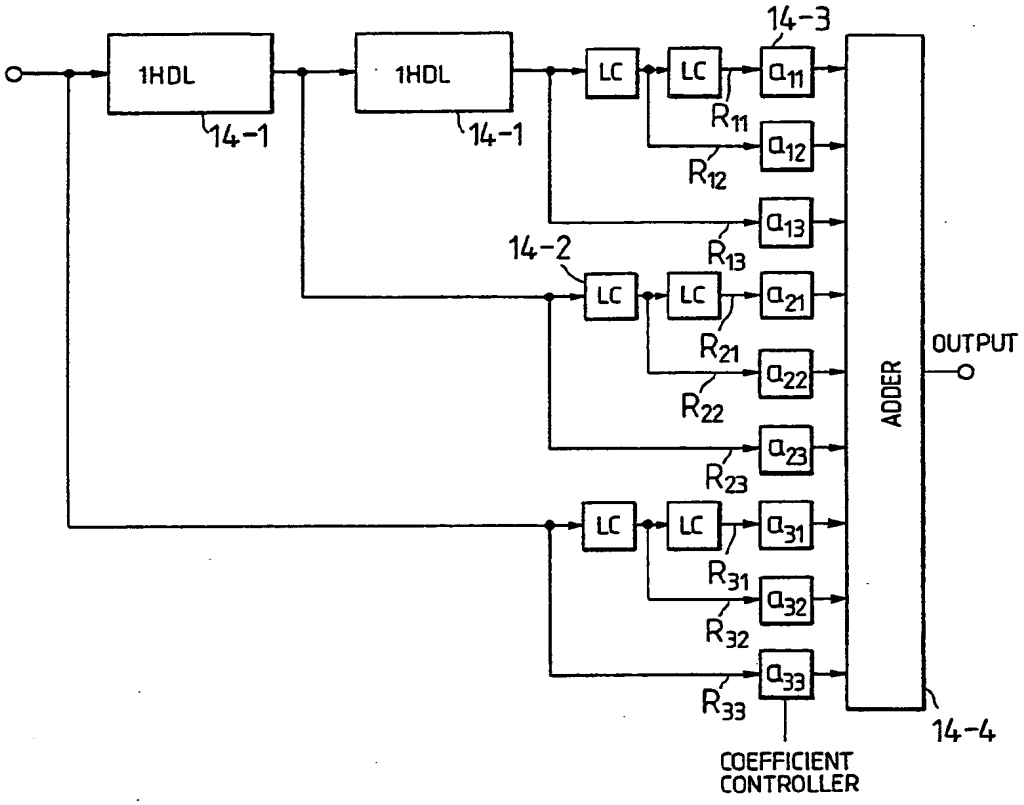

1HDL
1HDL
14-1
14-1
LC
LC
14-3
a_{11}
R_{11}
a_{12}
R_{12}
a_{13}
R_{13}
14-2
LC
LC
a_{21}
R_{21}
a_{22}
R_{22}
a_{23}
R_{23}
LC
LC
a_{31}
R_{31}
a_{32}
R_{32}
a_{33}
R_{33}
ADDER
OUTPUT
14-4
COEFFICIENT CONTROLLER

FIG. 5B

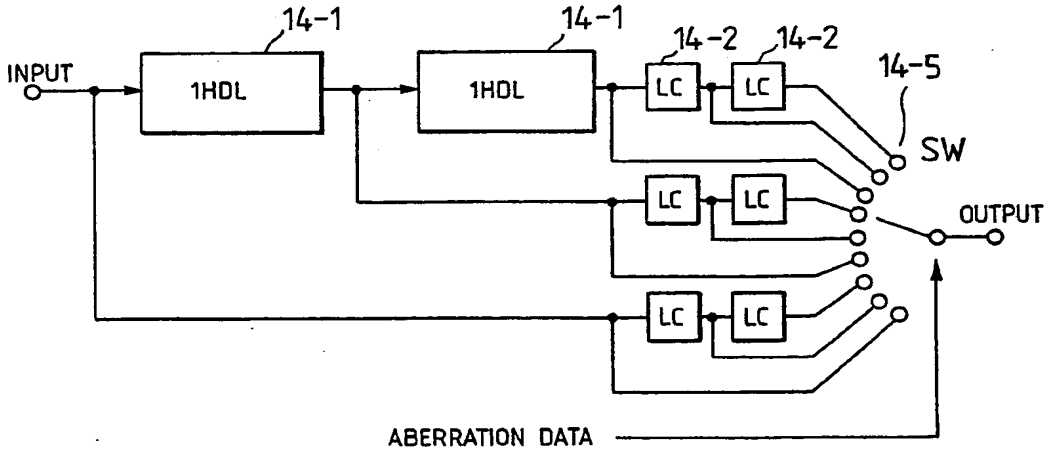

INPUT
14-1
1HDL
14-1
1HDL
14-2
14-2
LC
LC
14-5
SW
LC
LC
OUTPUT
LC
LC
ABERRATION DATA

FIG. 6

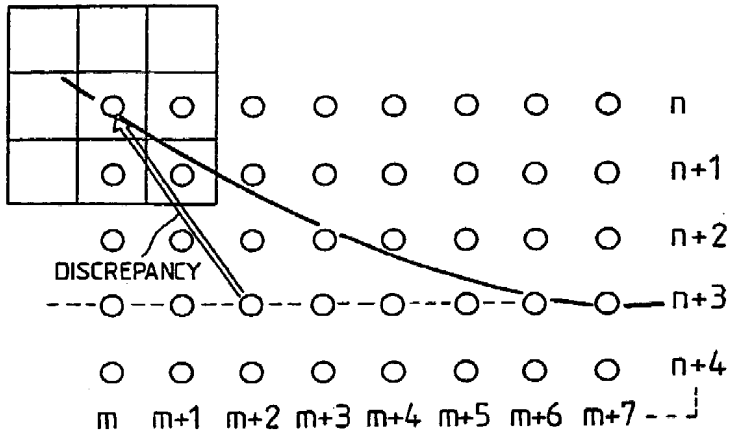


FIG. 11A

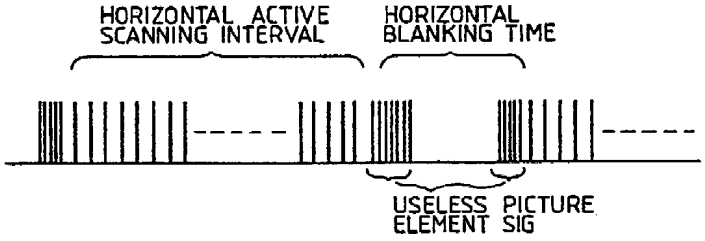


FIG. 11B

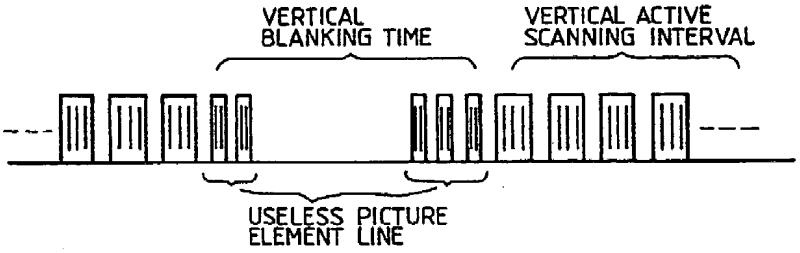


FIG. 7 PRIOR ART

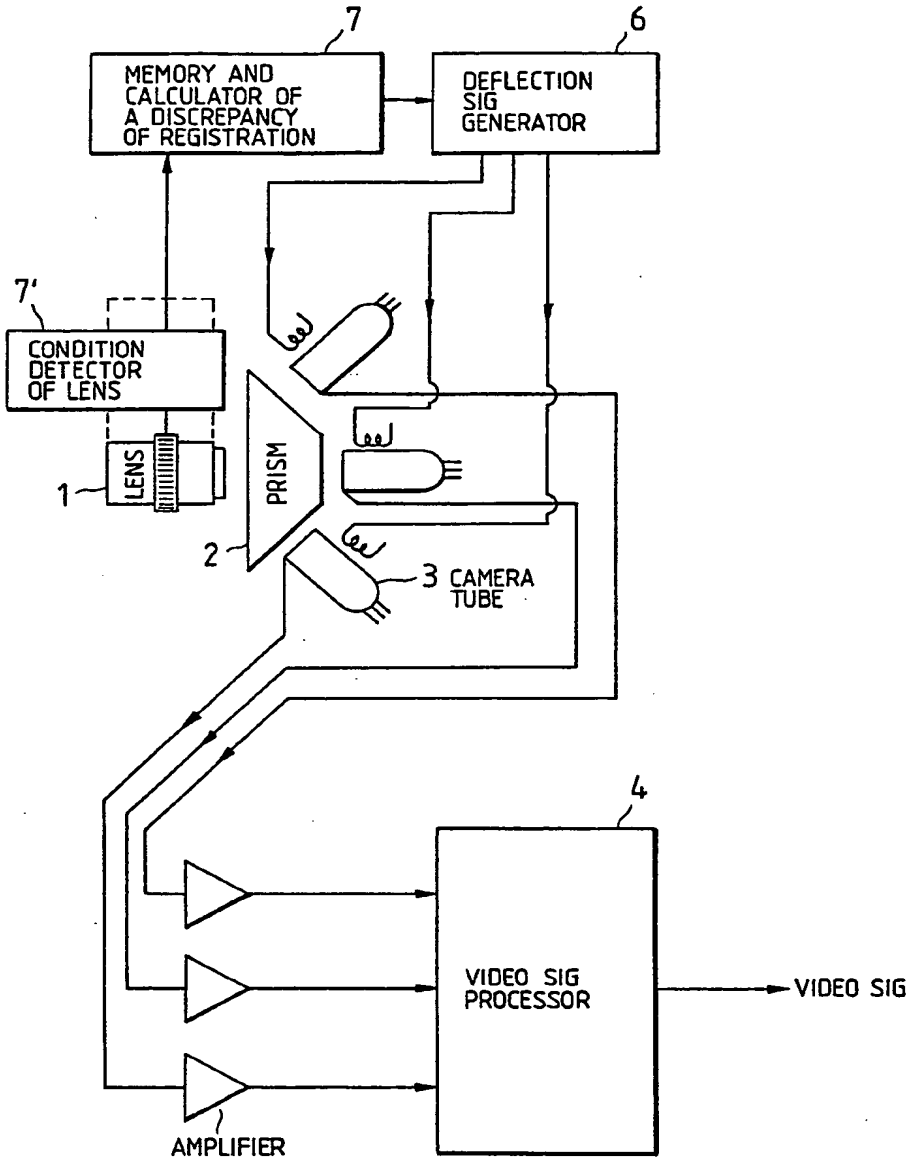


FIG. 8

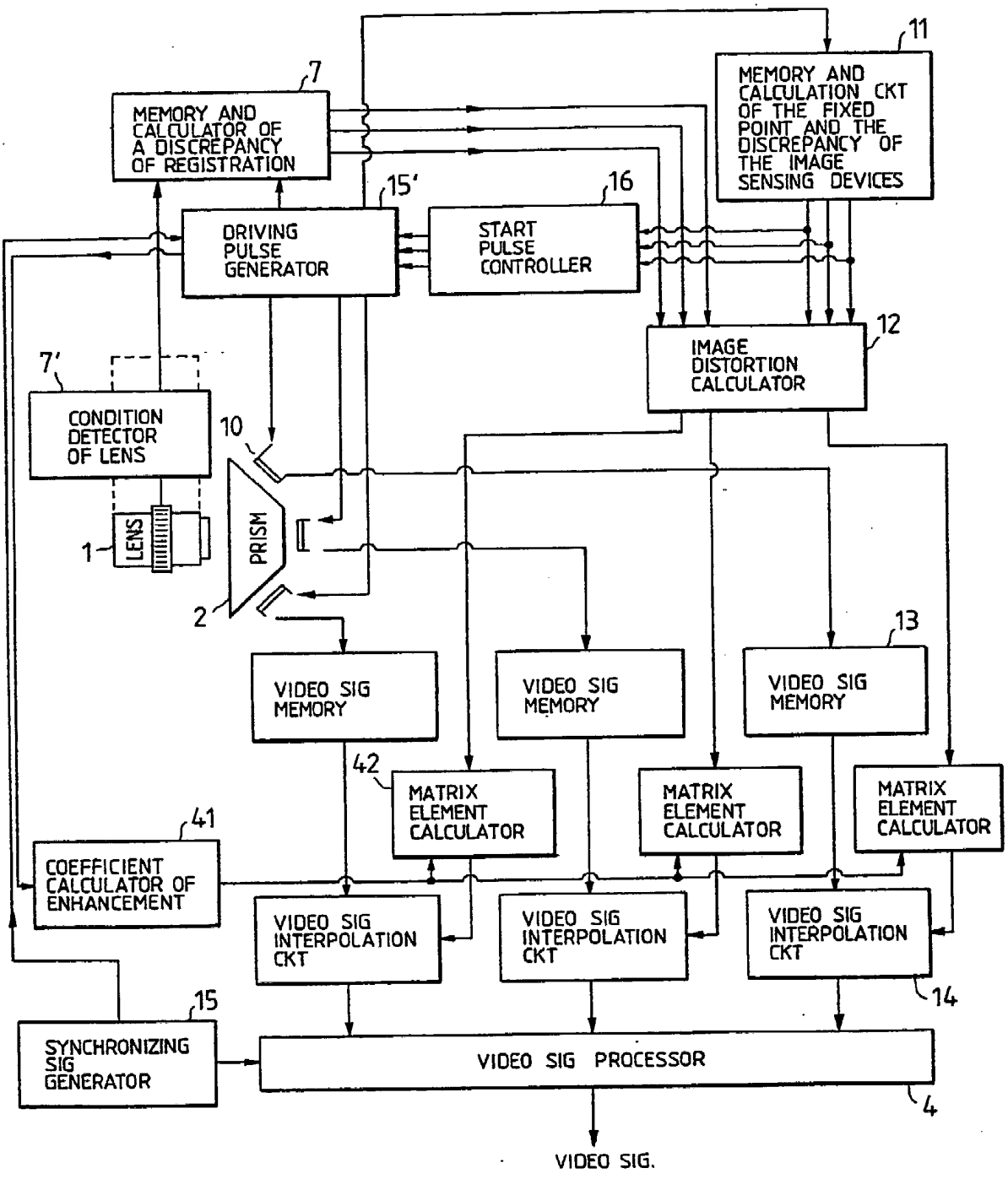

11
MEMORY AND CALCULATION CKT OF THE FIXED POINT AND THE DISCREPANCY OF THE IMAGE SENSING DEVICES
7
MEMORY AND CALCULATOR OF A DISCREPANCY OF REGISTRATION
15'
16
DRIVING PULSE GENERATOR
START PULSE CONTROLLER
12
IMAGE DISTORTION CALCULATOR
7'
CONDITION DETECTOR OF LENS
10
PRISM
LENS
1
2
13
VIDEO SIG MEMORY
VIDEO SIG MEMORY
VIDEO SIG MEMORY
42
MATRIX ELEMENT CALCULATOR
MATRIX ELEMENT CALCULATOR
MATRIX ELEMENT CALCULATOR
41
COEFFICIENT CALCULATOR OF ENHANCEMENT
VIDEO SIG INTERPOLATION CKT
VIDEO SIG INTERPOLATION CKT
VIDEO SIG INTERPOLATION CKT
14
15
SYNCHRONIZING SIG GENERATOR
VIDEO SIG PROCESSOR
4
VIDEO SIG.

FIG. 9

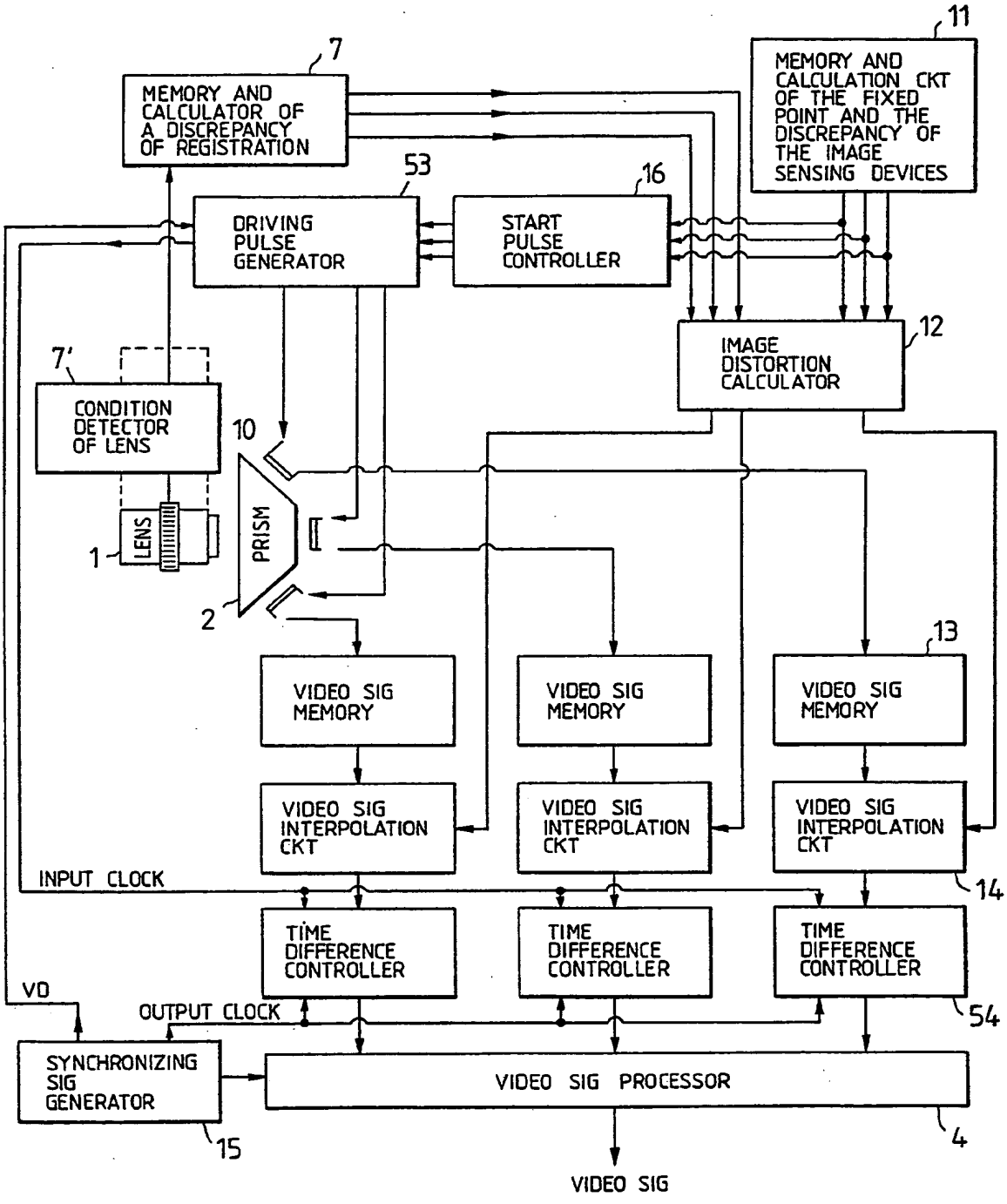

11
7
MEMORY AND CALCULATOR OF A DISCREPANCY OF REGISTRATION
MEMORY AND CALCULATION CKT OF THE FIXED POINT AND THE DISCREPANCY OF THE IMAGE SENSING DEVICES
53
16
DRIVING PULSE GENERATOR
START PULSE CONTROLLER
12
IMAGE DISTORTION CALCULATOR
7'
CONDITION DETECTOR OF LENS
10
PRISM
LENS
1
2
13
VIDEO SIG MEMORY
VIDEO SIG MEMORY
VIDEO SIG MEMORY
VIDEO SIG INTERPOLATION CKT
VIDEO SIG INTERPOLATION CKT
VIDEO SIG INTERPOLATION CKT
14
INPUT CLOCK
TIME DIFFERENCE CONTROLLER
TIME DIFFERENCE CONTROLLER
TIME DIFFERENCE CONTROLLER
54
VD
OUTPUT CLOCK
SYNCHRONIZING SIG GENERATOR
VIDEO SIG PROCESSOR
15
4
VIDEO SIG

FIG. 10A

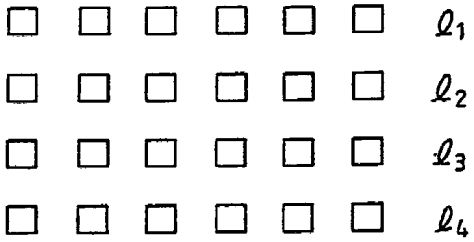


FIG. 10B

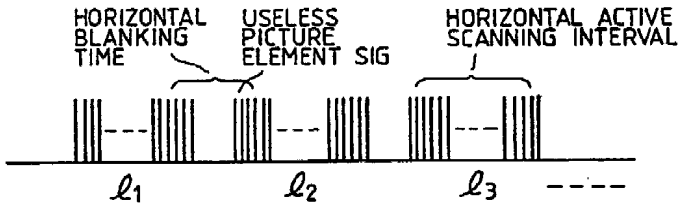


FIG. 10C

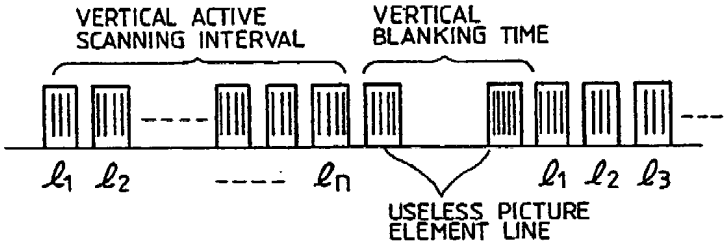


FIG. 12

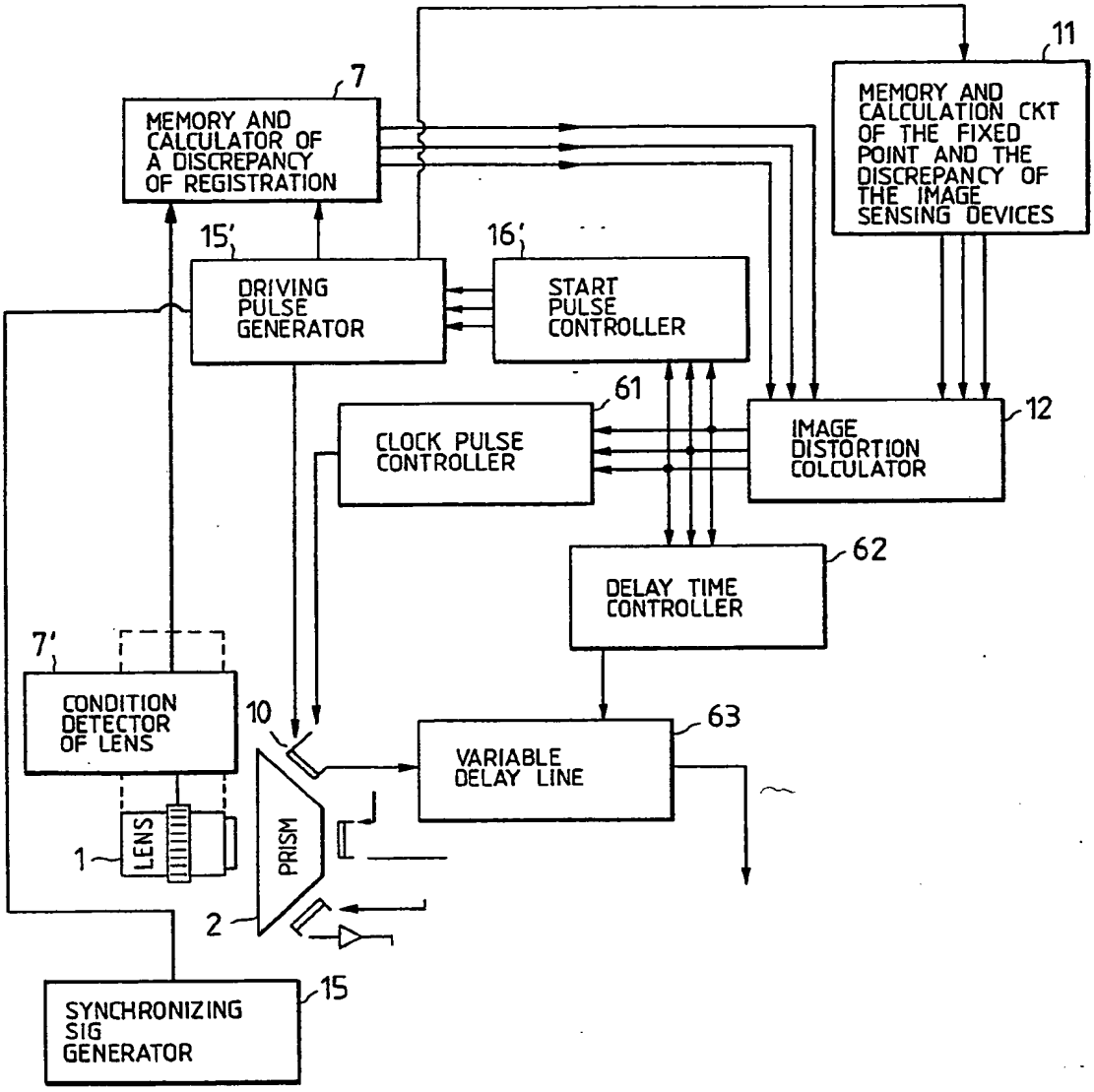

7
MEMORY AND CALCULATOR OF A DISCREPANCY OF REGISTRATION
11
MEMORY AND CALCULATION CKT OF THE FIXED POINT AND THE DISCREPANCY OF THE IMAGE SENSING DEVICES
15'
DRIVING PULSE GENERATOR
16'
START PULSE CONTROLLER
61
CLOCK PULSE CONTROLLER
12
IMAGE DISTORTION COLCULATOR
62
DELAY TIME CONTROLLER
7'
CONDITION DETECTOR OF LENS
10
63
VARIABLE DELAY LINE
LENS
1
PRISM
2
15
SYNCHRONIZING SIG GENERATOR

FIG. 13

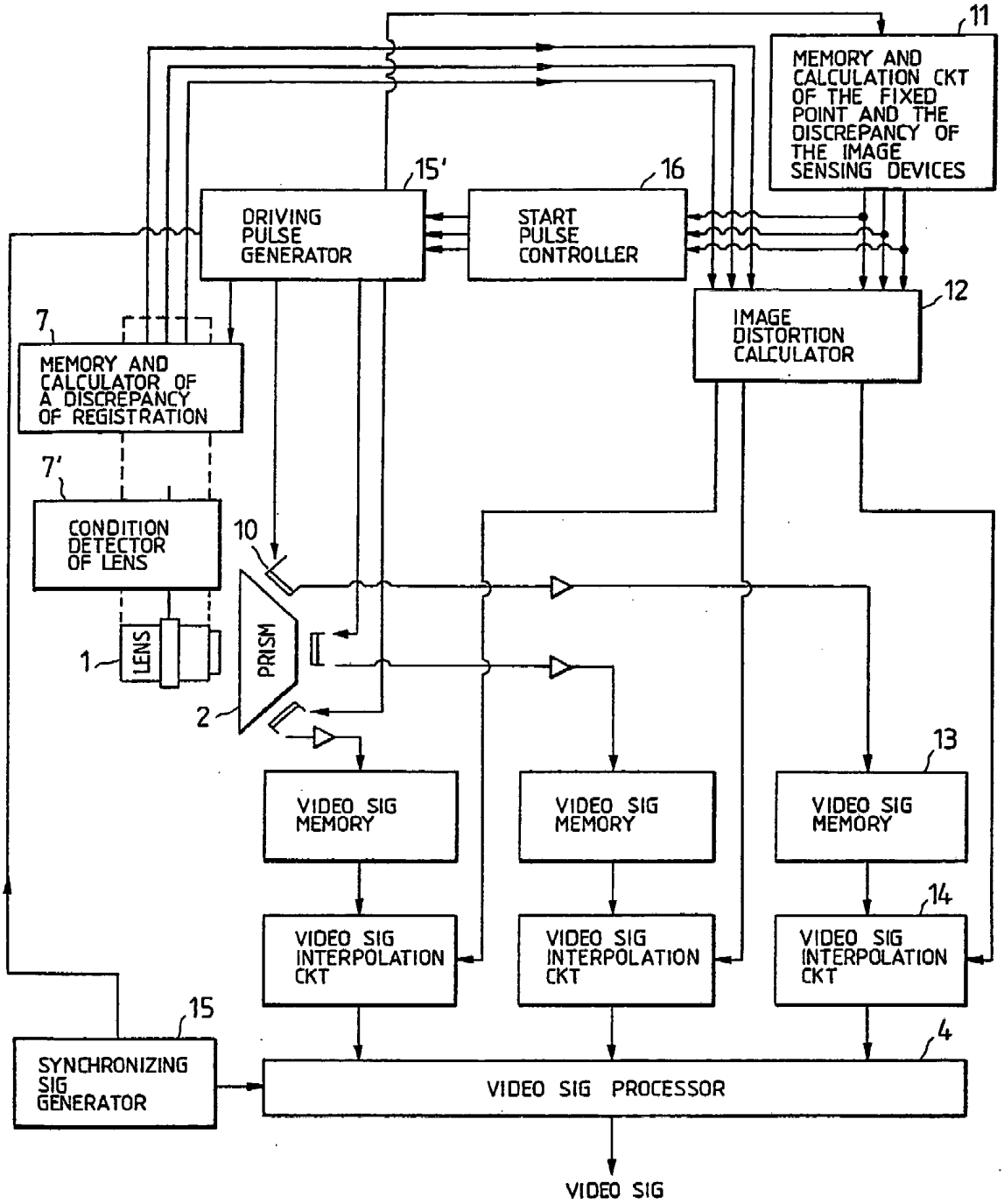

11
MEMORY AND CALCULATION CKT OF THE FIXED POINT AND THE DISCREPANCY OF THE IMAGE SENSING DEVICES
15'
DRIVING PULSE GENERATOR
16
START PULSE CONTROLLER
12
IMAGE DISTORTION CALCULATOR
7
MEMORY AND CALCULATOR OF A DISCREPANCY OF REGISTRATION
7'
CONDITION DETECTOR OF LENS
10
1
LENS
PRISM
2
13
VIDEO SIG MEMORY
VIDEO SIG MEMORY
VIDEO SIG MEMORY
14
VIDEO SIG INTERPOLATION CKT
VIDEO SIG INTERPOLATION CKT
VIDEO SIG INTERPOLATION CKT
15
SYNCHRONIZING SIG GENERATOR
4
VIDEO SIG PROCESSOR
VIDEO SIG

FIG. 14

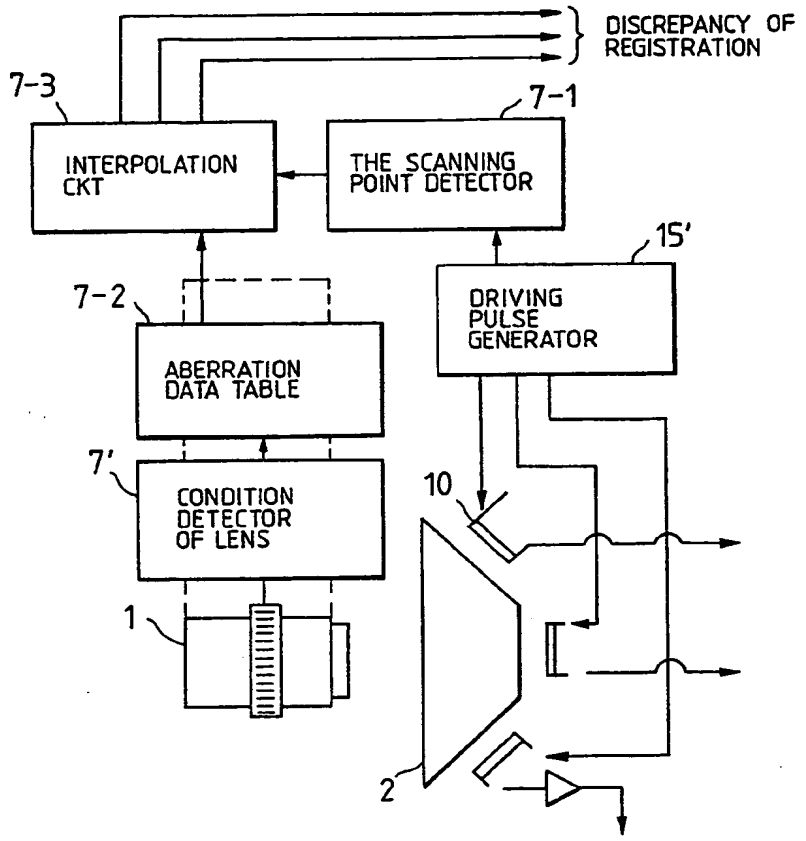
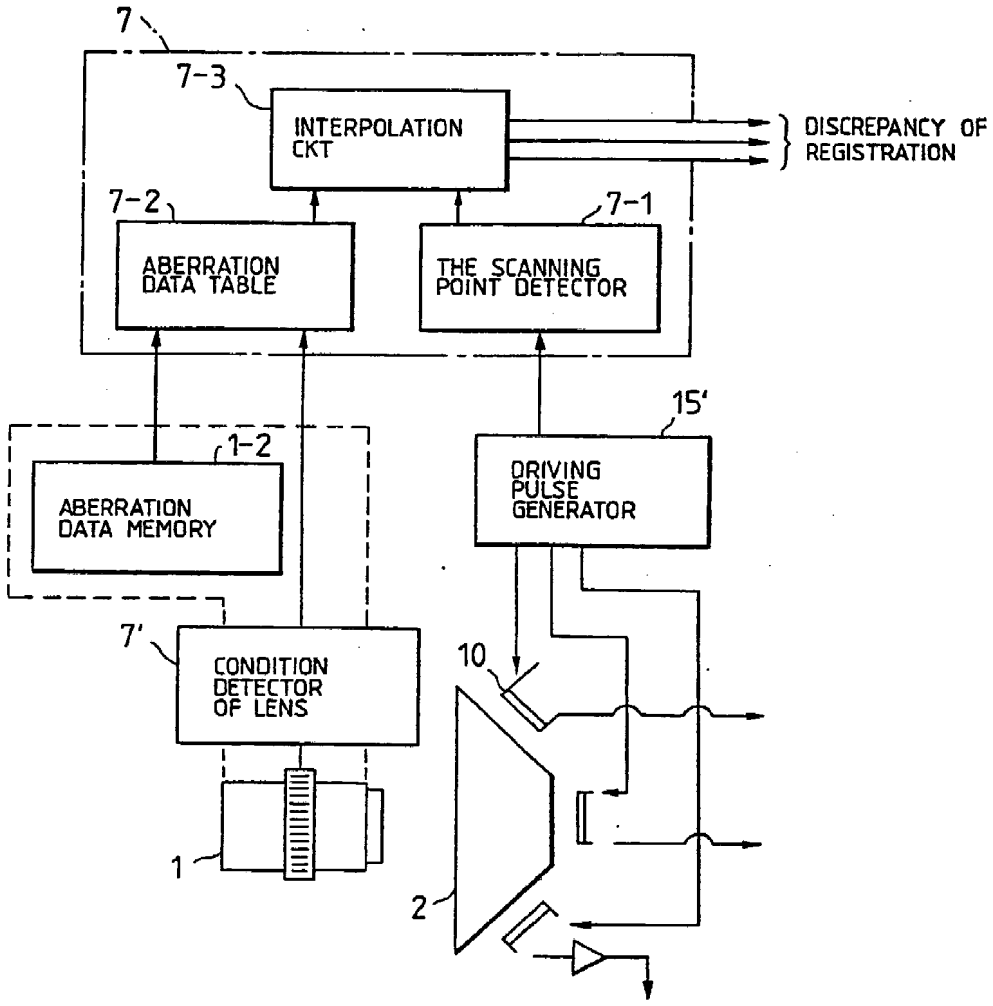

DISCREPANCY OF REGISTRATION
7-3
7-1
INTERPOLATION CKT
THE SCANNING POINT DETECTOR
15'
7-2
DRIVING PULSE GENERATOR
ABERRATION DATA TABLE
7'
CONDITION DETECTOR OF LENS
10
1
2

FIG. 15


7
7-3
INTERPOLATION CKT
DISCREPANCY OF REGISTRATION
7-2
ABERRATION DATA TABLE
7-1
THE SCANNING POINT DETECTOR
15'
1-2
ABERRATION DATA MEMORY
DRIVING PULSE GENERATOR
7'
CONDITION DETECTOR OF LENS
10
1
2